CLAIMS

Sub a6

1. An impact ionisation avalanche transit time (IMPATT) diode device (2) comprising a main avalanche region (10, 46) and a drift region (12, 44, 48), characterised in that the device additionally comprises a narrow bandgap region (4, 40) with a bandgap narrower than the bandgap in the main avalanche region (10, 46) which narrow bandgap region (4, 40) is located adjacent to the main avalanche region (10,46) in order to generate within the narrow bandgap region (4, 40) a tunnel current which is injected into the main avalanche region (10,46).

2. An IMPATT diode according to claim 1 wherein the narrow bandgap region (4, 40) is arranged to generate a tunnel current for injection into the main avalanche region (10, 46) at the peak reverse bias voltage applied to the diode.

3. An IMPATT diode according to claim 1 or claim 2 wherein the narrow bandgap region (4, 40) is located at the edge of the main avalanche region (10, 46).

4. An IMPATT diode according to any one of the preceding claims wherein the narrow bandgap region (4) is located between a heavily doped contact region (8) and the main avalanche region (10).

5. An IMPATT diode according to any one of the preceding claims wherein the narrow bandgap region (4, 40) comprises one layer of narrow bandgap material.

6. An IMPATT diode according to any one of claims 1 to 4 wherein the narrow bandgap region (4, 40) comprises a plurality of layers of narrow bandgap material.

7. An IMPATT diode according to any one of the preceding claims wherein the diode has a lo-hi-lo doping profile.

8. An IMPATT diode according to claim 7 wherein the diode is a Misawa p-i-n diode.

9. An IMPATT diode according to any one of claims 1 to 6 wherein the diode is a double drift diode.

10. An IMPATT diode according to any one of the preceding claims wherein the diode is made of III-V semiconductor materials.

11. An IMPATT diode according to any one of claims 1 to 7 wherein the diode is made of group IV semiconductor materials.

12. An IMPATT diode according to claim 11 wherein the narrow bandgap region (4, 40) is made of at least one layer of Silicon Germanium and the main avalanche region (10, 46) is made of Silicon.

13. An IMPATT diode according to claim 10 wherein the narrow bandgap region (4, 40) is made of at least one layer of Gallium Arsenide and the main avalanche region (10, 46) is made of Aluminium Gallium Arsenide.

14. An IMPATT diode according to any one of the preceding claims wherein the length of the drift region or regions (12, 44, 48) is between 2 and 6 times the length of the avalanche region (10, 46).

15. An IMPATT diode according to claim 14 wherein the length of the drift region or regions (12, 44, 48) is between 3.5 and 4.5 times the length of the avalanche region (10, 46).

16. An IMPATT diode according to any one of the preceding claimed arranged such that at least part of the tunnel current can be generated by optical excitation.

17. A method of operating an IMPATT diode according to any one of the preceding claims such that an oscillating voltage across the diode has a period of between 4 and 12 times the transit time of the avalanche region (10, 46).

18. A method according to claim 17 wherein the oscillating voltage has a period of between 7.5 and 8.5 times the transit time of the avalanche region (10, 46).

19. A method of operating an IMPATT diode according to any one of claims 1 to 17 including the step of optically exiting at least part of the tunnel current.